California High-Speed Train Project

TECHNICAL MEMORANDUM

CHSTP Candidate Trainsets – Vehicle Width
TM 600.01

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Note: Signatures apply for the latest technical memorandum revision as noted above.

Prepared by PB

for the California High-Speed Rail Authority

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ABSTRACT

This technical memorandum presents several key factors for consideration relative to specifying the width of the trainsets. As the CHSTP will be constructing new and upgrading existing infrastructure to meet the program requirements, a decision relative to vehicle width is necessary to allow designs and specifications to be further developed.

The High-Speed Rail Authority has previously adopted two key criteria relative to the trainsets which will influence system design. First, the trainsets, once in operation, must be able to travel at speeds of 220 mph (354 kph) in revenue service. Second, the procurement process should encourage competition and facilitate opportunities for a wide variety of manufacturers.

1.0 INTRODUCTION

1.1 PURPOSE OF TECHNICAL MEMORANDUM

The purpose of this memorandum is to present several key factors for consideration relative to specifying the width of the trainsets.

1.2 GENERAL INFORMATION

The CHSTP is in a unique position in that it will be designing and constructing infrastructure and associated systems that are purpose built to support a high speed (HS) operation. The CHSTP has an opportunity to specify a trainset configuration that would best meet the current and future requirements of the CHSTP operating plan.

The CHSTP system definition has been developed around the premise that the system will procure a nominal 1312 ft (400 m) trainset configuration, comprised of 2 – 656 ft (200 m) trainsets coupled together, capable of accommodating between 900 – 1000 passengers and of traveling at an operating speed of 220 mph (354 kph). The trainset is to be an existing service proven platform that either currently operates at the desired CHSTP operating speed of 220 mph (354 kph), or will be proven to operate in service at the desired speed prior to the start of CHSTP revenue service.

2.0 DEFINITION OF TECHNICAL TOPIC

None Applicable

3.0 ASSESSMENT / ANALYSIS

3.1 TRAINSET WIDTHS

Through our investigation into existing HS trainset designs, we have identified two main classifications of vehicle width. The first classification, termed as standard width, represents vehicle widths that range from 9.51 ft – 9.84 ft (2.9 m – 3.0 m). The second classification, termed as wide body width, represents vehicle widths that range from 10.50 ft – 11.15 ft (3.2 m – 3.4 m). The standard width trainsets typically operate throughout Europe, whereas the wide body configurations typically operate throughout Asia.

3.2 POTENTIAL CANDIDATE TRAINSETS

There are several trainset designs that can potentially meet CHSTP requirements in either a standard or wide body width configuration. Refer to Appendix A for a listing of these trainsets. It should be noted that the wide body width specification configuration would result in an increased level of competition as compared with the standard width candidate vehicles (see attached Appendix A with trainsets highlighted in green that can meet CHSTP requirements).

3.3 CAPACITY

The CHSTP operating plan is based on a nominal 656 ft (200 m) trainset having the capability of accommodating a minimum of 450 passengers. The operating plan also identifies two classes of service (e.g. first class and business class).

A standard width trainset typically is configured for a 2X1 first class seating arrangement and a 2X2 business class seating arrangement. A wide body width trainset can accommodate a 2X2 first class seating arrangement, as well as a high density 2X3 seating arrangement, should the Operator decide this seating configuration is necessary. The wide body width configuration provides an option for increasing seating capacity in the future as a 2X2 business class configuration will be specified initially.

FRA regulations for ADA (e.g. 49CFR38) identify spatial requirements to accommodate passengers in wheelchairs, and require accessible seating locations and toilet facilities to be distributed throughout the trainset. The wide body width trainset can better accommodate the ADA requirements, and can also provide for improved circulation through the trainset (e.g. wider aisles).

3.4 INTEROPERABILITY

The FRA has advised the CHSTP that it is seeking compatible solutions for HS trainsets, regardless of the project location. Although the scope of interoperability is currently being defined, it is possible that this will include compatibility of vehicle width and platform height. CHSTP's decision relative to vehicle width may influence other high speed rail (HSR) programs where interoperability might be envisioned.

In addition to the CHSTP, the FRA is evaluating the Florida and DesertXpress HSR programs. Although the current operating plans for these programs identify trainsets with differing performance characteristics (e.g. seating capacity, and maximum operating speed), the FRA is investigating areas of interoperability relative to the trainsets. Our understanding is that the DesertXpress has indicated that it would prefer to utilize a wide body width trainset, whereas the Florida program may seek a standard width solution due to the clearance limitations associated with operating within the I-4 highway median.

3.5 INFRASTRUCTURE

If wide body width trainsets are used, there will be no need for special provisions at stations to permit standard North American freight cars and maintenance equipment to pass an ADA compliant platform. Conversely, station platforms built to be ADA compliant for standard width trainsets will not permit passage of standard North American maintenance and freight equipment. To do so will require special provisions in the track, namely two extra rails and two sets of switch points, and the required space on the side opposite the platform will need to be larger.

Due to the rounded body shape of candidate HS trainsets, the trainsets will clear the standard low platform height and offset, 8 in (203 mm) above the top of rail and 5.08 ft (1.5 m) from centerline. There will be no difficulty in operating wide body equipment or transporting such equipment over any track built to pass standard North American freight equipment.

The use of wide body equipment permits a lower track cost, both initially and in operations, and simplifies operation in the Caltrain Corridor.

3.6 WEIGHT

The Siemens Velaro E (standard width) trainset and Velaro CN (wide body width) trainset have a total weight of 483.9 tons (439 tonnes) and 492.7 tons (447 tonnes) respectively. This equates to a 1.8% increase in weight for the wide body width trainset, with high density seating (2x3). The CHSTP vehicle specification will identify a maximum static axle load of 18.74 tons (17 tonnes) for either a standard or wide body width configuration.

3.7 COSTS

Accurate comparable capital costs of HS trainsets are difficult to establish. Manufacturers have been very reluctant to divulge the cost of their trainsets in the past. The information in the public domain is usually combined with costs for a HSR system or includes additional power cars or passenger coaches combined with complete trainsets.

Due to the limited cost information available relative to HS trainset procurements, it is difficult to develop an accurate comparison of standard width versus wide body width trainset costs. However, based on the number of potential wide body width trainset candidates, as shown in the attached matrix, and the fact that the wide body width design is a service proven platform, it is reasonable to conclude that the level of competition would remain high should the CHSTP decide

to procure wide body width trainsets. Appendix A identifies trainset costs gathered from our review of issued press releases.

4.0 SUMMARY AND RECOMMENDATIONS

4.1 CHSTP RECOMMENDATION

The CHSTP recommends that the Authority adopt the wide body width trainset configuration as it will provide:

- Increased passenger comfort utilizing a 2X2 first and business class seating arrangement
- Improved placement and configuration of ADA facilities
- Improved circulation throughout the trainset
- Increased competition
- Potential for increased capacity utilizing a 2X3 high density seating arrangement

As shown on the attached matrix, there are at least five manufacturers of trainsets who have designed/produced a wide body width trainset that are either in service, or will be designed to meet the CHSTP operating requirements.

5.0 SOURCE INFORMATION AND REFERENCES

None Applicable

6.0 DESIGN MANUAL CRITERIA

None Applicable

APPENDIX A

CALIFORNIA HIGH SPEED RAIL CANDIDATE TRAINSETS (REV 02.11)

	STANDARD WIDTH CONFIGURATION																				WIDE BODY WIDTH CONFIGURATION																			
	ALSTOM AGV 11[2]		NEW ALSTOM EMU[3]		ALSTOM TGV DUPLEX		BOMBARDIER ZEFIRO V300		FASTECH 360Z JAPAN SERIES E6[6]		FASTECH 360Z JAPAN SERIES E955[7]		ROTEM KTX-II		ROTEM HEMU-400X		SIEMENS VELARO D[11]		SIEMENS VELARO E		BOMBARDIER ZEFIRO 380		CHINA CRH380A		JAPAN SERIES E5[4]		FASTECH 360S JAPAN SERIES E954[5]		JAPAN SERIES N700[8]		JAPAN SERIES N700-I[9]		KAWASAKI efSET[10]		SIEMENS VELARO CN		TALGO AVRIL[12]	
																																						
TRAIN CONFIGURATION	4M+K+6T		4M+4T		L+8T+L		M+2T+2M+2T+M		5M+2T		5M+1T		L+8T+L		M (EMU)		4M+4T		4M + 4T		M+2T+2M+2T+M		6M + 2T		6M+2T		6M+2T		8M		8M		EMU		4M+4T		L+12T+L	
TRAIN DIMENSIONS																																									
Length	656 ft	200 m	N/A	N/A	656 ft	200 m	663 ft	202 m	489 ft	149 m	443 ft	135 m	659 ft	201 m	N/A	N/A	656 ft	200 m	656 ft	200 m	705 ft	215 m	667.32 ft	203.4 m	666 ft	203 m	673 ft	205 m	673 ft	205 m	673 ft	205 m	666 ft	203 m	656 ft	200 m	656 ft	200 m
Width	9.84 ft	3.00 m	N/A	N/A	9.51 ft	2.90 m	9.51 ft	2.90 m	9.68 ft	2.95 m	9.51 ft	2.90 m	9.67 ft	2.95 m	N/A	N/A	N/A	N/A	9.68 ft	2.95 m	11.15 ft	3.40 m	11.09 ft	3.38 m	10.99 ft	3.35 m	11.09 ft	3.38 m	11.02 ft	3.36 m	11.02 ft	3.36 m	11.09 ft	3.38 m	10.73 ft	3.27 m	10.50 ft	3.20 m
Height	13.53 ft	4.12 m	N/A	N/A	14.11 ft	4.30 m	12.76 ft	3.89 m	11.98 ft	3.65 m	11.98 ft	3.65 m	13.45 ft	4.10 m	N/A	N/A	N/A	N/A	12.76 ft	3.89 m	12.76 ft	3.89 m	12.14 ft	3.70 m	11.98 ft	3.65 m	11.98 ft	3.65 m	11.81 ft	3.60 m	11.81 ft	3.60 m	12.14 ft	3.70 m	12.76 ft	3.89 m	N/A	N/A
TRAIN WEIGHT	451.9 tons	410 tonnes	N/A	N/A	468.5 tons	425 tonnes	599.7 tons	544 tonnes	338.4 tons	307 tonnes	275.6 tons	250 tonnes	478.4 tons	434 tonnes	N/A	N/A	N/A	N/A	483.9 tons	439 tonnes	514.8 tons	467 tonnes	529.1 tons	480 tonnes	396.8 tons	360 tonnes	368.2 tons	334 tonnes	395.6 tons	358 tonnes	402.3 tons	365 tonnes	496.0 tons	450 tonnes	492.7 tons	447 tonnes	347.2 tons	315 tonnes
SEATING[1]																																								
1ST Class	35 seats / car (2x1)		N/A		76 seats / car (2x1)		60 seats / car (2x2)		23 seats / car (2x2)		25 seats / car (2x1 and 2x2)		30 seats / car (2x1)		N/A		52/61 seats / car (2x2)		38/103 seats / 1st Class (2x1)		N/A		56 seats / car (2x2)		18 seats / car (2x1) 55 seats / car (2x2)		51 seats / car (2x2)		68 seats / car (2x2)		68 seats / car (2x2)		47 seats / car (2x2)		72 seats / 1st Class (56 2x2 and 16 2x1)		N/A	
2ND Class	50 seats / car (2x2)		N/A		76 seats / car (2x2)		80 seats / car (3x2)		315 seats / 2nd Class (2x2)		259 seats / 2nd Class (2x2)		52 seats / car (2x2)		N/A		40/65 seats / car (2x2)		264 seats / 2nd Class (2x2)		N/A		85 seats / car (3x2)		473 seats / 2nd Class (3x2)		520 seats / 2nd Class (2x2 and 3x2)		100 seats / car (3x2)		100 seats / car (3x2)		42/92 seats / car (3x2)		528 seats / 2nd Class (3x2)		N/A	
Dining / Bar	D: 18 seats / car B: 24 seats / car		N/A		16 seats / car		28 seats / car		N/A		N/A		16 seats / car		N/A		N/A		0 seats / car		N/A		36 seats / car		N/A		N/A		24 seats / car		N/A		N/A		N/A		N/A	
Total / Train	460 seats / train		N/A		510 seats / train		600 seats / train		338 seats / train		284 seats / train		363 seats / train		N/A		476 seats / train		405 seats / train		664 seats / train		553 seats/train (aprox.)		546 seats / train		571 seats / train		662 seats / train		636 seats / train		491 seats / train		601 seats/train		470 seats / train	
AXLES / TRAIN																																								
Motored Axles	12		16		8		16		20		20		8		N/A		16		16		16		24		24		24		32		32		N/A		16		8	
Total	24		32		26		32		28		24		26		N/A		32		32		32		32		32		32		32		32		32		32		21	
BOGIE CENTERS																																								
Lead	56.1 ft	17100 mm	N/A	N/A	45.9 ft	14000 mm	57.0 ft	17375 mm	46.4 ft	14150 mm	48.2 ft	14700 mm	N/A	N/A	N/A	N/A	N/A	N/A	57.0 ft	17375 mm	57.0 ft	17375 mm	57.4 ft	17500 mm	57.4 ft	17500 mm	57.4 ft	17500 mm	57.4 ft	17500 mm	57.4 ft	17500 mm	57.4 ft	17500 mm	57.4 ft	17500 mm	N/A	N/A
Trailer	56.8 ft	17300 mm	N/A	N/A	61.4 ft	18700 mm	57.0 ft	17375 mm	46.4 ft	14150 mm	48.2 ft	14700 mm	N/A	N/A	N/A	N/A	N/A	N/A	57.0 ft	17375 mm	57.0 ft	17375 mm	57.4 ft	17500 mm	57.4 ft	17500 mm	57.4 ft	17500 mm	57.4 ft	17500 mm	57.4 ft	17500 mm	57.4 ft	17500 mm	57.4 ft	17500 mm	N/A	N/A
AXLE CENTERS	9.8 ft	3000 mm	N/A	N/A	9.8 ft	3000 mm	9.4 ft	2850 mm	8.2 ft	2500 mm	8.2 ft	2500 mm	N/A	N/A	N/A	N/A	N/A	N/A	8.2 ft	2500 mm	8.9 ft	2700 mm	8.2 ft	2500 mm	8.2 ft	2500 mm	8.2 ft	2500 mm	8.2 ft	2500 mm	8.2 ft	2500 mm	N/A	N/A	8.2 ft	2500 mm	N/A	N/A
FLOOR HEIGHT	45.67 in	1160 mm	N/A	N/A	21.65 in	550 mm	49.21 in	1250 mm	51.18 in	1300 mm	51.18 in	1300 mm	N/A	N/A	N/A	N/A	48.82 in	1240 mm	48.82 in	1240 mm	49.21 in	1250 mm	51.18 in	1300 mm	51.18 in	1300 mm	51.18 in	1300 mm	15.18 in	1300 mm	51.18 in	1300 mm	N/A	N/A	49.60 in	1260 mm	N/A	N/A
TRAIN HORSEPOWER	11800 hp	8800 kW	13410 hp	10000 kW	11800 hp	8800 kW	11800 hp	8800 kW	8050 hp	6000 kW	9720 hp	7250 kW	11800 hp	8800 kW	N/A	N/A	10700 hp	8000 kW	11800 hp	8800 kW	13410 hp	10000 kW	12874 hp	9600 kW	9650 hp	7200 kW	11500 hp	8600 kW	13100 hp	9760 kW	13100 hp	9760 kW	14750 hp	11000 kW	11800 hp	8800 kW	11800 hp	8800 kW
MAX DESIGN SPEED	224 mph	360 kph	249 mph	400 kph	199 mph	320 kph	261 mph	420 kph	224 mph	360 kph	249 mph	400 kph	205 mph	330 kph	249 mph	400 kph	218 mph	350 kph	218 mph	350 kph	260 mph	420 kph	236 mph	380 kph	224 mph	360 kph	249 mph	400 kph	186 mph	300 kph	205 mph	330 kph	218 mph	350 kph	218 mph	350 kph	236 mph	380 kph
MAX IN-SERVICE SPEED	186 mph	300 kph	224 mph	360 kph	186 mph	300 kph	224 mph	360 kph	199 mph	320 kph	224 mph	360 kph	186 mph	300 kph	218 mph	350 kph	199 mph	320 kph	186 mph	300 kph	236 mph	380 kph	218 mph	350 kph	199 mph	320 kph	224 mph	360 kph	186 mph	300 kph	205 mph	330 kph	218 mph	350 kph	218 mph	350 kph	236 mph	380 kph
	Italy - NTV		N/A		France - SNCF		Italy - Trenitalia		Japan - Shinkansen		Japan - Experimental		Korea - Korail		Korea - "Concept"		Germany - DB (2011 plan)		Spain - RENFE		China - CRH		China - CRH		Japan - Shinkansen		Japan - Experimental		Japan - Shinkansen		N/A		N/A		N/A		China - CRH (2010 plan)		Spain - "Concept"	
FRA COMPLIANCE	No		No		No		No		No		No		No		No		No		No		No		No		No		No		No		No		No		No		No	
APPROX. TRAIN COST	$35 million		N/A		$34 million		$40.7 million		N/A		N/A		N/A		N/A		$42 million		$27 million		$28.6 million		N/A		N/A		N/A		$18 million		N/A		N/A		$28.5 million		N/A	

Abbreviations:
K: Key Car; L: Locomotive; M: Motor; T: Trailer; EMU: Electric Multiple Unit

Notes:
Candidates highlighted in Green show greatest potential as a candidate trainsets for the CHSTP.

[1]Seating is designed to meet individual operator's requirements and is not fixed by the manufacturer.
[2]AGV utilizes distributed power; all cars are articulated; details shown are for an 11-car trainset; trains may be configured as 7, 8, 10, 11, or 14 cars.
[3]This new Alstom non-articulated EMU trainset will be designed and manufactured according to the customers' needs. There is no "generic" trainset.
[4]The values for the E5 series are calculated with a length limit of 203 m (666 ft) to accommodate CHSTP requirements. The typical configuration of the E5 series is 8M + 2T and is 253 m (830 ft) in length.
[5]The E954 series trainset is an experimental 8-car trainset only.
[6]The E6 series utilize a narrow body configuration designed to accommodate travel on conventional routes in Japan.
[7]The E955 series trainset is an experimental 6-car trainset only. Except for the leading bogies of the end cars, all other bogies are powered.
[8]N700 trains have various seating configurations per car; seats shown are average; train weight is average calculated from the 16-car weight (715 tonnes).
[9]The N700-I series is JR Central's intended export trainset. This trainset can be configured as 6 through 16 cars.
[10]The efSET is Kawasaki's new concept trainset designed to accommodate the import market's requirements. The seating configurations are as proposed to the CHSTP via the 2009 WBPF.
[11]The seating configurations for the Velaro D are as proposed to the CHSTP via the 2009 WBPF. The train cost represents the potential cost per trainset for the new Velaro trains should Siemens win the Eurostar contract. Siemen's contract with DB in 2008 had a value of approximately $47 million per trainset.
[12]The train weight of the Talgo Avril is 7% less than the weight of the Talgo 350. The AVRIL trainset should be completed and ready for homologation by September 2011. US Rep = Antonio Perez 202-286-0622.

Sources for Train Cost (note: the values shown represent a snapshot in time and are estimates based on reported procurements; the stated values are determined utilizing historical exchange rates for the contract period):
Alstom AGV: http://www.railwaygazette.com/nc/news/single-view/view/agv-tipped-to-win-ntv-contract.html - Exchange rate used: 1 USD = 0.73 EUR (2007 annual average)
Alstom TGV Duplex: http://www.railwaygazette.com/nc/news/single-view/view/sncf-confirms-duplex-order.html - Exchange rate used: 1 USD = 0.74 EUR (Jun 27, 2007); based on the fluctuation in the exchange rate, the price of TGV Duplex trainset ranged from 34M USD to 35M USD at the time.
Bombardier Zefiro 380: http://www.railwaygazette.com/news/single-view/view/china-orders-380-kmh-zefiro-high-speed-trains.html - Exchange rate used: 1 USD = 6.83 CNY (Sep 28, 2009)
Bombardier Zefiro V300: http://www.railwaygazette.com/nc/news/single-view/view/trenitalia-signs-v300zefiro-high-speed-train-contract.html - Exchange rate used: 1 USD = 0.76 EUR (Aug 5, 2010)
Siemens Velaro E: http://www.railwaygazette.com/nc/news/single-view/view/velaro-e-enters-service.html - Exchange rate used: 1 USD = 1.15 EUR (July 2001) and 0.80 (March 2004); the 26 trainset/650M EUR contract for the Velaro E was split into two orders - the first order for 16 trainsets was placed in July 2001 whereas the second order for 10 trainsets was placed in March 2004. The trainset price in the matrix represents the average of the two values after exchange.
Siemens Velaro CN: http://www.railwaygazette.com/nc/news/single-view/view/siemens-high-speed-train-sets-sail-for-china.html - Exchange rate used: 1 USD = 0.80 EUR (2005 annual average)
Siemens Velaro D: http://www.usa.siemens.com/industry/us/hsr-portal/_assets/whitepaper_velaro_en.pdf - Exchange rate used: 1 USD = 0.79 EUR (Dec 1, 2008)
Shinkansen N700: http://www.japaneserailwaysociety.com/N700/N700.pdf; http://www.railway-technology.com/projects/n700-shinkansen/ - Exchange rate used: I USD = 124.88 JPY (Jun 14, 2002); based on the fluctuation in the exchange rate, the price of an N700 trainset ranged from 18M USD to 19M USD.